Proposed Improvements For The V6 AIRS RTA

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Introduction

- The Level 2 AIRS Radiative Transfer Algorithm (RTA) is a non-scattering forward model
- We recently developed an IASI RTA very similar to the V5 AIRS for NOAA/NESDIS (Barnet). *However, we used some new H_2O and minor gas spectroscopy in the IASI RTA.*
- We are currently producing a new AIRS (V6?) RTA, regardless of whether it will be used in the AIRS V6 PGE. (We need identical AIRS and IASI RTA's to cross-validate AIRS and IASI to better than 0.1K.)
- Not all AIRS (V6?) RTA changes have been finalized.

Definite Changes

- Bug fix for CO_2, N_2O, SO_2, and HNO_3 dummy profile adjustment
- Improved variable SO_2 modeling in dry conditions
- Adding some fake (filled) channels; see L1C presentation.
- Revised spectroscopy for H_2O, O_3, SO_2, and HNO_3. These now use the latest HITRAN 2004 database, while all other gases still use HITRAN 2000 as changes are generally negligible.
  - Large O_3 change between HITRAN 2000 and 2004 in $10\mu m$ region already approximated in V5 via optical depth tuning.
  - H_2O changes significant in a handful of channels, but otherwise are generally minor.
  - SO_2 and HNO_3 changes nearly invisible.

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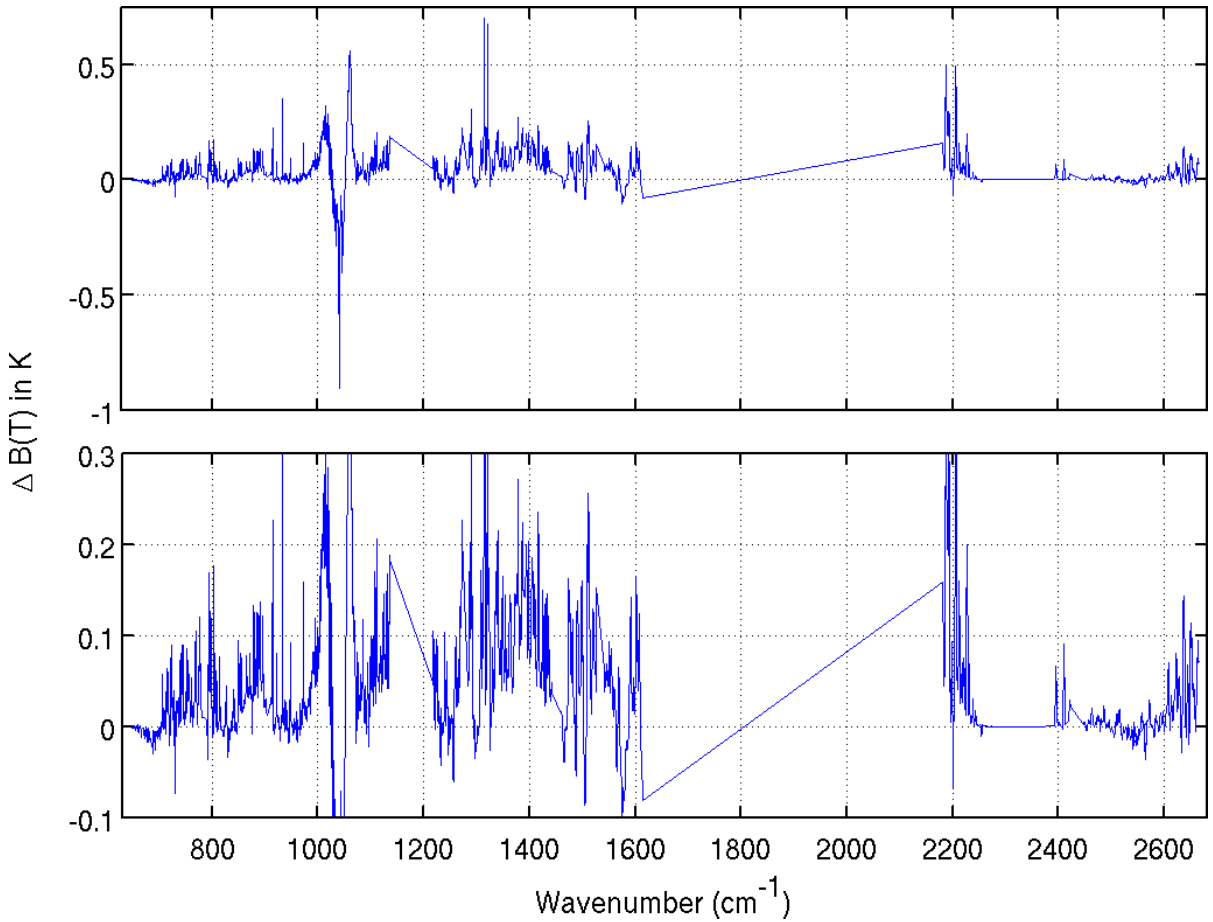
Spectroscopy Changes ΔBT

Panels are identical, just different y-axis scale.

This graph gives an upper estimate of changes between the V5 and possible V6 RTAs. Note that the O_3 changes will be much smaller.



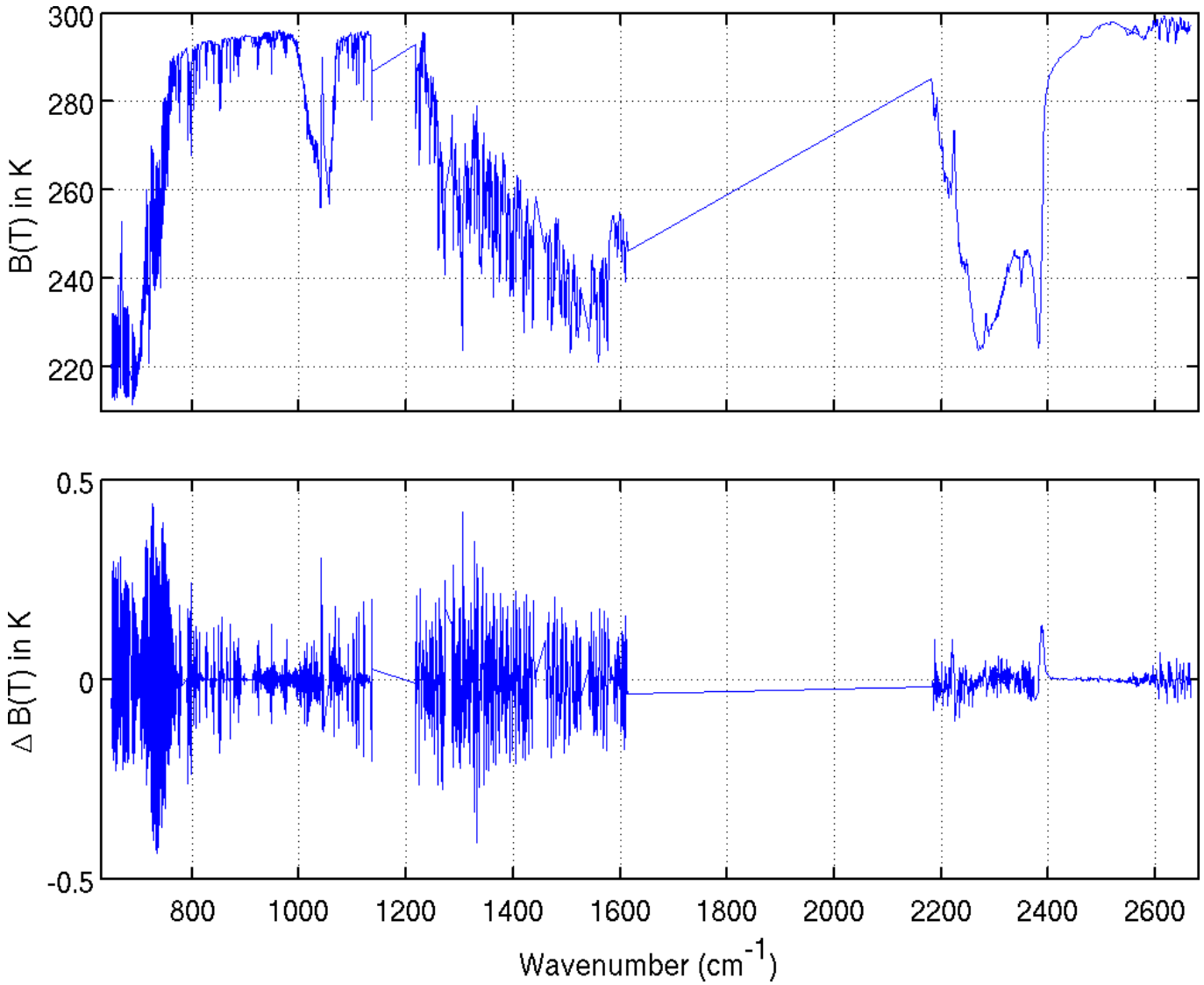
Revised Optical Depth Tuning

- The V5 RTA used “optical depth tuning” in some channels for some gases to bring calculations into better agreement with observations, based on coincident RS-90 sondes during AIRS validation campaign.
- Tuning adjustments thought to be primarily correcting for spectroscopy errors, but may include instrument modelling errors (SRFs and fringes).
- May be able to improve spectroscopy/tuning by comparing AIRS and IASI obs-calc. Need DOE-ARM TWP IASI/AIRS sonde results.
- Revised V6 spectroscopy requires revised V6 optical depth tuning. Will re-visit this in the summer time-frame.

Channel Frequency Drift, Part 1

- AIRS channels have a slow long term frequency drift that we estimate will shift the channels about 1% of a channel width to higher freqs between years 2002-2013. See our L1C presentation for more details.
- We are producing V6 RTAs on 3 different frequency grids that cover the expected variation in the true AIRS SRF centroids over the life of the instrument.
- We recommend a new standard fixed frequency set placed at the nominal mid-mission location. One of the RTAs will be for this frequency grid. The others will be displaced by $\pm 1\%$ of the SRF width.

Effects of A 1% Frequency Shift



Channel Frequency Shift, part 2

- Short-term orbital frequency shifts may be important for retrievals (see Evan Manning's talk)
- Given these three RTAs, V6 retrievals could:
  - Continue doing all retrievals at nominal frequencies
  - Attempt to track frequency shifts using interpolated RTA coeffcients. This approach would use a parameterized frequency calibration model (see L1C talk).

Pre- and Post-Nov.2003 Coefficient Databases

- Minor AIRS design flaw resulted in “fringes” (aka channel spectra) in Spectral Response Functions.
- Fringe position is a function of AIRS operating temperature
- AIRS was deliberately shutdown in late Oct.2003 due to huge solar storm.
- In mid Nov.2003 the AIRS channel freqs were reset to their Sep.2002 position, but this required a small change in the AIRS operating temperature. Thus the fringes shifted.
- For V6 we will make available separate RTA databases for pre- and post-Nov 2003.
- Some effects of fringe shift visible throughout AIRS spectra, but mostly in 2180-2200 cm^{-1} CO region.

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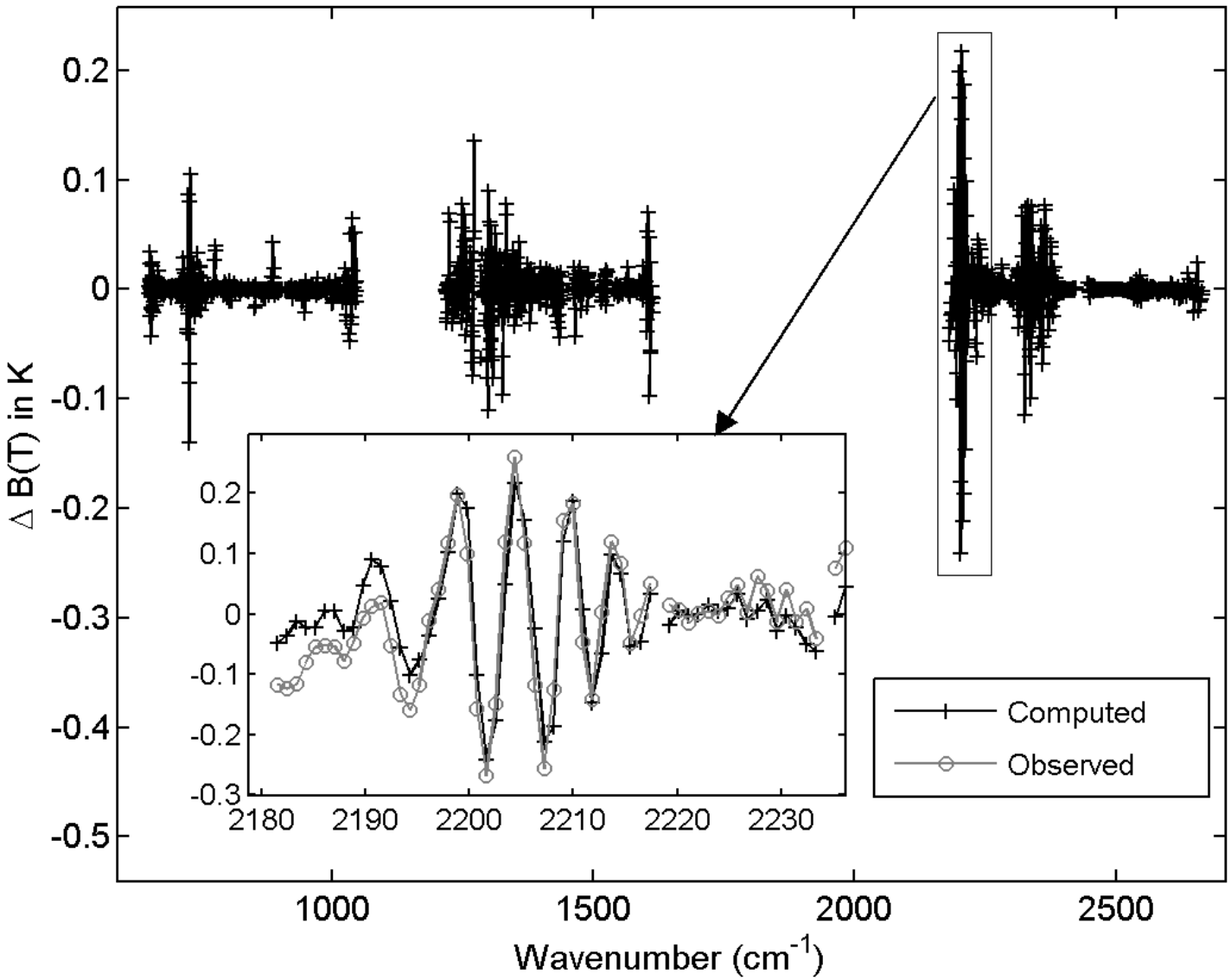
Fringe Shift ΔB(T) Due to Nov. 2003 Shutdown

S. Hannon



Scatter/Cloudy RTA

- Current V5 AIRS RTA algorthm can only handle clear sky, or crude black clouds with transmittance = 0 and emissivity = 1
- Over the last few years we have developed cloudy sky variants of the RTA which can do transmissive and scattering clouds
- The cloudy sky RTA is more complicated and slower than the clear sky code. Maybe double the complexity and runtime.
- It would be a big job to implement the cloudy RTA in the PGE due to all the “plumbing” changes it would require. *We do not have the expertise to do this.*
- Retrieval of dust and cirrus properties would be main uses for scattering RTA. Our approach is OK for long-wave, but has limitations in short-wave.

Summary and Plans

- A new AIRS RTA(s) is in development for V6.
- Slightly revised spectroscopy to bring it up-to-date.
- Revised spectroscopy will require we re-do at least some of the optical depth tuning. Big job, will be done in stages.
- Not yet sure how/if frequency drift will be dealt with
- Separate databases for pre- and post-Nov.2003 fringe positions.
- Scattering RTA for V6??